

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
28 March 2002 (28.03.2002)

PCT

(10) International Publication Number  
WO 02/24033 A1

(51) International Patent Classification<sup>7</sup>: A47C 7/46 (74) Agent: DONAHUE, Dennis, J., M., III; Thompson Coburn LLP, One Firststar Plaza, St. Louis, MO 60101 (US).

(21) International Application Number: PCT/US01/28863

(22) International Filing Date:  
14 September 2001 (14.09.2001)

(81) Designated States (national): AU, BR, CA, CN, IL, IN, JP, MX.

(25) Filing Language: English

(84) Designated States (regional): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

(30) Priority Data:  
09/664,209 18 September 2000 (18.09.2000) US

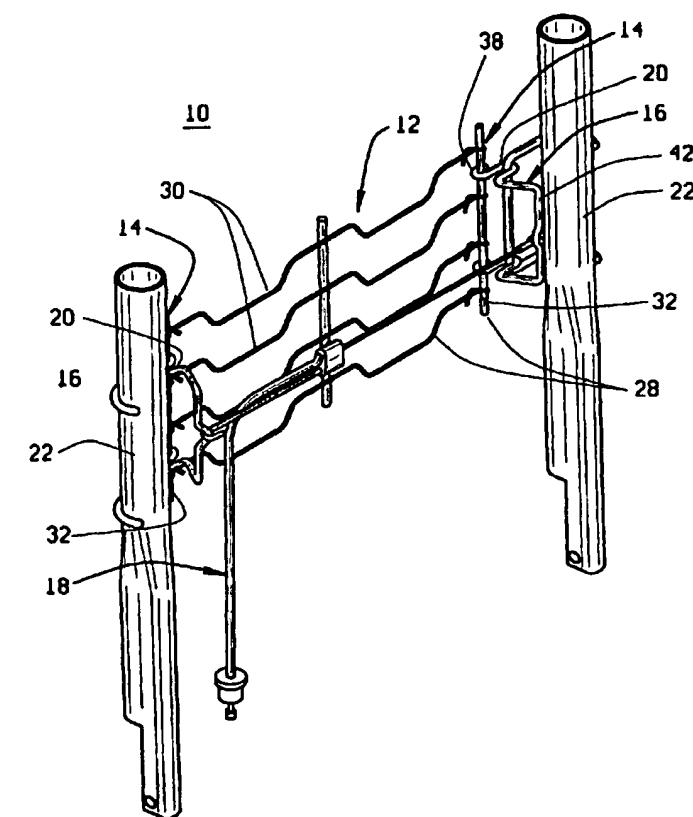
**Published:**  
— with international search report  
— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

(71) Applicant: L & P PROPERTY MANAGEMENT COMPANY [US/US]; 4095 Firestone Boulevard, South Gate, CA 90280 (US).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(72) Inventor: LONG, Harold, Dwayne; 111 High Street, Sarcocie, MO 64862 (US).

(54) Title: ADJUSTABLE LUMBAR SUPPORT



(57) Abstract: A lumbar support device (10), preferably secured in a seat frame (22), includes a support structure (12) attached between a pair of levers (16) that are rotated by an actuator assembly (18). In one embodiment, the pair of levers are each formed from a serpentine wire, and each lever wraps around a bar that is secured to the seat frame and wraps around a side of the support structure. The actuator assembly rotates the pair of levers which move the support structure into the lumbar region and pull the support structure in tension.

WO 02/24033 A1

## ADJUSTABLE LUMBAR DEVICE

## CROSS-REFERENCE TO RELATED APPLICATIONS

Not Applicable.

5 STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR  
DEVELOPMENT Not Applicable.

## BACKGROUND OF THE INVENTION

## 1. FIELD OF THE INVENTION

10 This invention relates generally to lumbar support devices and particularly to lumbar support devices that are capable of changing shape, especially curvature in the lumbar region.

## 2. DESCRIPTION OF RELATED ART

15 Lumbar support devices have been integrated into seats to change their shape, thereby allowing each occupant to adjust the support provided by the seat. The curvature of these devices are traditionally adjustable so that an occupant can operate the device to push the seat forward towards the occupant's spinal column in the lumbar region. It is generally known to change the curvature of a lumbar support  
20 device using an actuator assembly that moves a support structure. It is also well known to provide an actuator assembly with an effector that is either manually operated, using a handle or a knob, or power-assisted, using a drive motor and control switches. Increased curvature is usually accomplished by moving the support

structure forward into the lumbar region, rotating sections of the support structure into the lumbar region, or bowing the support structure out into the lumbar region.

As discussed below, these known devices operate on the general principles of increasing the firmness or stiffness of the support structure and changing the shape of

5 the lumbar support device. Many devices produce a uniform curvature across the lumbar region such that the sides of the support structure curve as much as the center portion of the support structure. However, these devices do not increase the stiffness of the support structures. Similarly, a prior art device that increases the stiffness of the support structure does not produce a uniform curvature across the lumbar region.

10 It would be good to increase the stiffness of the support structure and also provide uniform curvature across the support structure.

Examples of lumbar support devices in which the support structure is moved forward into the lumbar region are found in U.S. Patent 4,159,847 and U.S. Patent 5,452,868. In the first invention, the device is secured to a frame such that the

15 support structure is in tension even in a relaxed position. A handle attached to a pair of levers linked to opposite sides of a grid. By rotating the handle, the pair of levers rotate and the grid is thereby moved forward into the lumbar region. Each lever is linked to the grid through a coil spring that produces the tension across the support structure and provides the support structure with a stiffness. Similarly, U.S. Patent

20 5,452,868 discloses a lumbar support device that uses a single powered lever that to push a lumbar support panel forward into the lumbar region. Although the levers in these inventions uniformly move the support structure forward, they do not increase the stiffness of the support structure.

Examples of lumbar support devices in which sections of the support structure are rotated into the lumbar region are found in U.S. Patent 4,564,235 and U.S. Patent 5,823,620. In the first invention, a pair of plates are rotated into the lumbar region. The plates are situated laterally across the lumbar region and thereby

5 provide uniform curvature across the support structure. However, the tension across the plates is not increased when the plates are rotated and the stiffness of the plates is not increased. The lumbar support device disclosed in U.S. Patent 5,823,620 uses a bowden cable in the actuator assembly to rotate a pair of levers that respectively rotate a pair of pads into the lumbar region. The pads are situated horizontally and

10 do not provide uniform curvature across the support structure, and the stiffness of each lever and its respective pad is not increased.

Examples of lumbar support devices in which the support structure is bowed out into the lumbar region are found in U.S. Patent 4,588,172 and U.S. Patent 5,651,584. In the first invention, the support structure is formed by a sinusoidal spring attached to a grid and positioned between two discs. The discs are attached to a rod and skewed in opposite directions, and a handle is attached to one end of the rod. By rotating the handle from a relaxed position, the rod rotates and the skewed discs rotate away from each other, thereby pulling the spring tighter and flexing the center portion of the spring into the lumbar region. The sinusoidal spring is bowed

15 forward, increasing the tension in the support structure. Although the increased tension increases the stiffness of the support structure, the spring bows laterally across the lumbar region causing a bulge in the center of the lumbar region and resulting in negligible curvature at each side of the lumbar region. Therefore, the

lumbar region of a person sitting in such a seat would not be supported at the sides as with a device that produces a uniform curvature across the lumbar region. For example, U.S. Patent 5,651,584 bows a support structure such that a uniform curvature is produced across the lumbar region.

5       Typically, many lumbar support devices use levers in the actuator assemblies. For the lumbar support devices that use levers, the support structures and actuator assemblies in these devices are generally constructed of materials that are manufactured from individual components and attached by hardware, such as rivets, screws, wire-ties, welds and bolts. Therefore, the designs of these devices require  
10      manual assembly operations, including the manual attachment of coil springs and sub-assemblies requiring rivets or welds, and are not well suited for a simplified assembly process.

#### BRIEF SUMMARY OF THE INVENTION

15       It is in view of the above problems that the present invention was developed. The invention is a lumbar support device, preferably for use in a seat frame, having a support structure attached between a pair of levers that are rotated by an actuator assembly. In one embodiment, the support structure is formed by a grid having multiple flexible wires securely wrapped around a pair of border wires at opposing  
20      sides of the support structure. The support structure has an integral spring formed by a sinusoidal pattern of the multiple flexible wires. Each of the pair of levers is formed from a serpentine wire that wraps around a bar that is secured to the seat and wraps around one of the border wires. The actuator assembly uses a hook and a

hooked rod to link the pair of levers, and a bowden cable connects an effector with the hook and the hooked rod. The effector pulls on the bowden cable causing the hook and hooked rod to pull on the pair of levers and resulting in the rotation of the levers. In response, the levers move the grid into the lumbar region, thereby 5 producing uniform curvature across the support structure, and pull the grid in tension, thereby increasing the support structure's stiffness.

In another embodiment, the support structure has a pair of coil springs attached between the pair of levers. The pair of levers are secured to the seat frame. As in the first embodiment, the actuator assembly uses a hook and a hooked rod to 10 link the pair of levers, and a bowden cable connects an effector with the hook and the hooked rod. The effector pulls on the bowden cable causing the hook and hooked rod to pull on the pair of levers and resulting in the rotation of the levers. In response, the levers move the support structure into the lumbar region, thereby producing uniform curvature across the support structure, and pull the support 15 structure in tension, thereby increasing the stiffness of the support structure.

Therefore, it is an advantage of this invention to provide a lumbar support device capable of increasing the stiffness of the support structure and producing uniform curvature across the support structure.

It is another advantage of the present invention to provide a lumbar support 20 device capable of producing uniform curvature movement with a lever and support structure that uses fewer parts and hardware than the related art.

It is yet another advantage of the present invention to provide a process for increasing the stiffness and curvature of a lumbar support device.

Further features and advantages of the present invention, as well as the structure and operation of various embodiments of the present invention, are described in detail below with reference to the accompanying drawings.

5

#### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of the specification, illustrate the embodiments of the present invention and together with the description, serve to explain the principles of the invention. In the drawings:

Figure 1 illustrates a perspective view of a lumbar support device in a frame  
10 according to one embodiment of the present invention;

Figure 2 illustrates a top plan view of the lumbar support device in Figure 1 in  
a relaxed position with an alternate actuated position superimposed with a broken  
line; and

Figure 3 illustrates a front elevation view of the lumbar support device in  
15 Figure 1;

Figure 4 illustrates a perspective view of a lumbar support devices in a seat  
frame according to a second embodiment of the present invention;

Figure 5 illustrates a side elevation view of the lumbar support device in  
Figure 4 in a relaxed position; and

20 Figure 6 illustrates a side elevation view of the lumbar support device in  
Figure 4 in a curvature position.

## DETAILED DESCRIPTION OF THE INVENTION

Referring to the accompanying drawings in which like reference numbers indicate like elements, Figures 1-3 illustrate one embodiment of a lumbar support device 10 according to the present invention. The lumbar support device 10 has a support structure 12 with opposing sides 14 that are attached between a pair of levers 16. The levers 16 are rotated by an actuator assembly 18 around a pair of fulcrums 20 that are respectively secured to a frame 22.

Figure 2 particularly illustrates the lumbar support device 10 in a relaxed position and an alternate actuated position shown in broken lines. The actuator assembly 18 moves the levers 16 from a first position 24 that corresponds to the relaxed position to a second position 26 that corresponds with the actuated position. The lumbar support device 10 is secured to the frame 22 such that when a person's lower back (not shown) engages the frame, the support structure 12 corresponds with the person's lumbar region. The levers 16 uniformly move the support structure 12 forward into the lumbar region, from the relaxed position to the actuated position, resulting in uniform curvature across the support structure. Additionally, moving the levers 16 from the first position 24 to the second position 26 increases tension across the support structure 12, thereby stiffening the support structure.

In this first embodiment, the support structure 12 is formed by a grid 28 having multiple flexible wires 30 securely wrapped around a pair of border wires 32 at the opposing sides 14 of the support structure. At least one of the flexible wires 30 is a sinusoidal wire 34, thereby forming an integral spring in the support structure 12. Each lever 16 is preferably formed from a serpentine wire 36. Each serpentine wire

36 has a pair of s-shaped loops 38 that wrap around each respective border wire 32 and a bar 40 that secured to the frame 22. The s-shaped loops 38 are separated by a u-shaped loop 42 that has a dimple 44. Accordingly, the pair of serpentine wires 36 wrap around the pair of bars 40 attached to the frame 22.

5        The actuator assembly 18 links the pair of levers 16 with a hook 46 and a hooked rod 48, respectively, latching onto each lever's dimple 44 on opposing sides 14 of the support structure 12. An effector 50 is connected to the hook 46 and the hooked rod 48 through a bowden cable 52. The bowden cable 52 has a sheathed section 54 between the effector 50 and a base 56 of the hooked rod 48, and the 10 bowden cable has an unsheathed section 58 between the base and the hook 46. The effector 50 pulls on the bowden cable 52, causing the hook 46 and hooked rod 48 to pull on the pair of levers 16, thereby rotating the levers. In response, the levers 16 move the grid 28 into the lumbar region, thereby producing uniform curvature across the support structure. The levers 16 also pull the grid 28 in tension, causing the 15 sinusoidal wire 34 to extend and thereby increasing the stiffness of the support structure 12.

      A second embodiment of the present invention is illustrated in Figures 4-6. As in the first embodiment, the second embodiment of the lumbar support device 10 includes a support structure 12 with opposing sides 14 that are attached between a 20 pair of levers 16. An actuator assembly 18 rotates the levers 16 around a pair of fulcrums 20 that are respectively secured to a frame 22 that is preferably formed in a seat or chair (not shown). A typical pivoting lever 100 is illustrated in the second

embodiment, although the serpentine wire 36 from the first embodiment could also be used.

Figures 5 and 6 particularly illustrate the lumbar support device 10 in a relaxed position and an alternate actuated position, respectively. As in the first 5 embodiment, the actuator assembly 18 moves the levers 16 from a first position 24 that corresponds to the relaxed position to a second position 26 that corresponds with the actuated position. The levers 16 uniformly move the support structure 12 forward into the lumbar region, from the relaxed position to the actuated position, resulting in uniform curvature across the support structure. Additionally, moving the levers 16 10 from the first position 24 to the second position 26 increases the tension across the support structure 12, thereby increasing the support structure's stiffness.

In the second embodiment, the lumbar support device 10 is secured to the seat frame 22 through a plurality of springs 102. The support structure has a pair of coil springs 104 at the opposing sides 14 that are attached to the pair of levers 16. As in 15 the first embodiment, the actuator assembly 18 causes the levers 16 to rotate. In response, the levers 16 move the support structure 12 into the lumbar region, thereby producing uniform curvature. The levers 16 also pull the support structure 12 in tension, causing the pair of coil springs 104 to extend and thereby stiffening the support structure 12. Although the support structure 12 in the second embodiment is 20 preferably a grid 28 as in the first embodiment, it is not limited to a grid because the extension of the coil springs 104 increases the stiffness. Therefore, coil springs 104 can vary the stiffness in the support structure 12 even if the portion of the support structure between the coil springs is rigid.

The first embodiment and the second embodiment use the same process to stiffen the support structure 12 and uniformly move the support structure into the lumbar region. The support structure 12 is secured within a frame 22 in the lumbar region. In the relaxed position, the support structure 12 has a particular curvature and 5 stiffness that could be zero or could have some non-zero value. The support structure 12 is moved forward in the lumbar region, thereby increasing the curvature across the support structure compared to the relaxed position. Additionally, the support structure 12 is pulled between the frame 22 in the lumbar region, thereby stiffening the support structure compared to the relaxed position. In both embodiments, pulling 10 the support structure 12 increases the tension across the support structure. In the first embodiment, the increased tension causes the sinusoidal wire 34 to extend and stiffen, acting as an integral spring. In the second embodiment, increased tension causes the coil spring 104 to extend and stiffen

Securing the support structure 12 to the frame 22 is performed by linking the 15 pair of levers 16 through the actuator assembly 18, attaching the levers to opposing sides 14 of the support structure 12 and respectively securing the levers to the frame at the pair of fulcrums 20 in the lumbar region. Additionally, the support structure 12 is secured to the frame 22 outside the lumbar region. Pulling the pair of levers 16 with the actuator assembly 18 causes the levers to respectively rotate around the pair 20 of fulcrums 20, resulting in pushing the opposing sides 14 of the support structure 12 forward and pulling the opposing sides 14 of the support structure 12 towards the frame 22.

In view of the foregoing, it will be seen that the several advantages of the invention are achieved and attained. The embodiments were chosen and described in order to best explain the principles of the invention and its practical application to thereby enable others skilled in the art to best utilize the invention in various 5 embodiments and with various modifications as are suited to the particular use contemplated.

As various modifications could be made in the constructions and methods herein described and illustrated without departing from the scope of the invention, it is intended that all matter contained in the foregoing description or shown in the 10 accompanying drawings shall be interpreted as illustrative rather than limiting. For example, it will be evident to those skilled in the art that the pair of coil springs 104 taught in the second embodiment could be replaced with other types of springs. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in 15 accordance with the following claims appended hereto and their equivalents.

## CLAIMS

What is Claimed Is:

1. A lumbar support device capable of curvature movement in a lumbar region between a relaxed position and an actuated position and capable of being integrated into a frame, comprising:
  - a support structure having opposing sides;
  - a pair of levers attached to said support structure at said opposing sides, said pair of levers having a pair of fulcrums respectively secured to the frame; and
  - 10 an actuator assembly operatively attached to said pair of levers such that said levers can be moved from a first position corresponding to the relaxed position to a second position corresponding to the actuated position, thereby stiffening said support structure between said levers and uniformly moving said support structure forward in the lumbar region.
- 15 2. A lumbar support device according to claim 1, wherein said actuator assembly further comprises:
  - an effector;
  - a bowden cable having a sheathed section operatively connected to said effector and an unsheathed section;
- 20
  - a hook attached to said unsheathed section of said bowden cable; and
  - a hooked rod having a base attached to said sheathed section of said bowden cable, wherein said hook and said hooked rod are respectively attached to said pair of levers at said opposing sides of said support structure.

3. A lumbar support device according to claim 1, wherein said support structure has a pair of coil springs at said opposing sides and said pair of levers are attached to said support structure through said pair of coil springs.

4. A lumbar support device according to claim 3, wherein said support structure further comprises a grid having a plurality of flexible wires securely wrapped around a pair of border wires at said opposing sides.

5. A lumbar support device according to claim 4, wherein said actuator assembly further comprises:

an effector;

10 a bowden cable having a sheathed section operatively connected to said effector and an unsheathed section;

a hook attached to said unsheathed section of said bowden cable; and

15 a hooked rod having a base attached to said sheathed section of said bowden cable, wherein said hook and said hooked rod are respectively attached to said pair of levers at said opposing sides of said support structure.

6. A lumbar support device according to claim 1, wherein said support structure further comprises a grid having a plurality of flexible wires securely wrapped around a pair of border wires at said opposing sides.

7. A lumbar support device according to claim 6, wherein said support structure has at least one sinusoidal wire in said plurality of flexible wires forming an integral spring in said support structure.

8. A lumbar support device according to claim 7, wherein said actuator assembly further comprises:

an effector;

a bowden cable having a sheathed section operatively connected to said effector and an unsheathed section;

a hook attached to said unsheathed section of said bowden cable; and

5 a hooked rod having a base attached to said sheathed section of said bowden cable, wherein said hook and said hooked rod are respectively attached to said pair of levers at said opposing sides of said support structure.

10. A lumbar support device according to claim 6, further comprising a pair of bars secured to the frame, and wherein said pair of levers are formed from a 10 pair of serpentine wires wrapped around said pair of bars.

11. A lumbar support device according to claim 10, wherein said pair of serpentine wires each have a pair of s-shaped loop separated by u-shaped loop, said s-shaped loop wrapping around said border wires and said pair of bars, and wherein said u-shaped loop has a dimple for latching said hook and said hooked rod.

15 12. A lumbar support device capable of curvature movement in a lumbar region between a relaxed position and an actuated position and capable of being integrated into a frame having a bar, comprising:

a means for supporting the lumbar region;

20 a pair of levers operatively attached to said support means, each of said pair of levers formed from a serpentine wire having a pair of loops wrapped around the bar and a u-shaped loop connecting said pair of loops; and means for moving said levers from a first position corresponding to the relaxed position to a second position corresponding to the actuated position.

13. A lumbar support device according to claim 12, wherein said means for moving said levers is comprised of at least one actuator assembly operatively attached to said pair of levers.

14. A lumbar support device according to claim 12, wherein said pair of 5 loops wrapped around the bar forms a fulcrum for each of said pair of levers.

15. A process for increasing curvature and stiffness in a lumbar region from a relaxed position, comprising said steps of:

securing a support structure within a frame in the lumbar region, said support structure having a curvature and a stiffness in the relaxed position;

10 uniformly moving said support structure forward in the lumbar region and thereby increasing said curvature of said support structure from the relaxed position; and

15 pulling said support structure between said frame in the lumbar region and thereby increasing said stiffness of said support structure from the relaxed position.

16. A process according to claim 15, wherein pulling said support structure forces a tension across said support structure.

17. A process according to claim 15, wherein the step of securing said lumbar support device further comprises the steps of:

20 linking a pair of levers through an actuator assembly;

attaching said pair of levers to opposing sides of said support structure in the lumbar region;

securing said pair of levers to said frame through a pair of fulcrums; and

securing said support structure to said frame outside the lumbar region.

18. A process according to claim 17, wherein the step of uniformly moving said support structure further comprises the steps of:

pulling said pair of levers with said actuator assembly;

5           rotating said pair of levers around said pair of fulcrums; and

pushing said opposing sides of said support structure forward with said pair of levers.

19. A process according to claim 17, wherein the step of pulling said support structure further comprises the steps of:

10           pulling said pair of levers with said actuator assembly;

rotating said pair of levers around said pair of fulcrums; and

pulling said opposing sides of said support structure out towards said frame with said pair of levers.

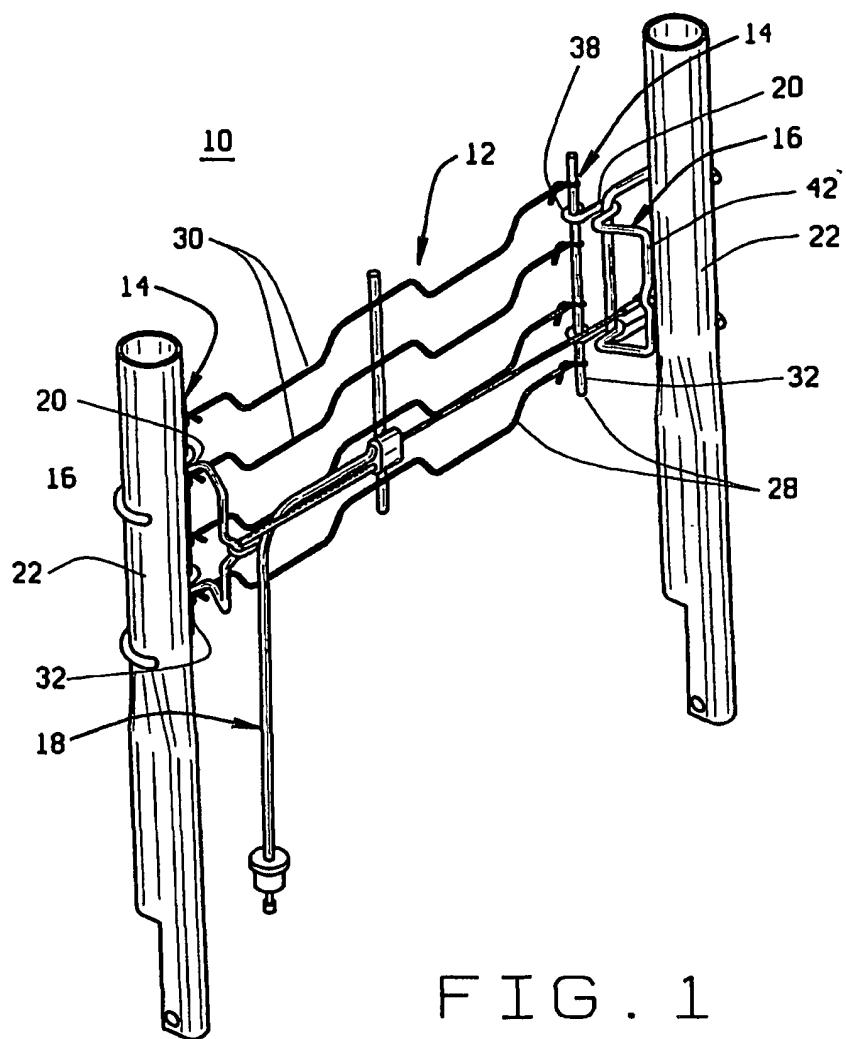


FIG. 1

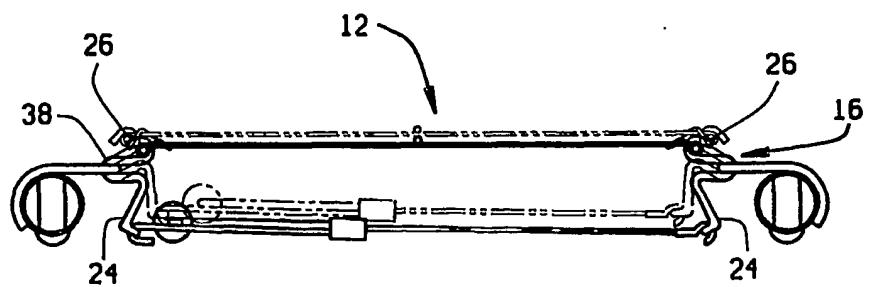


FIG. 2

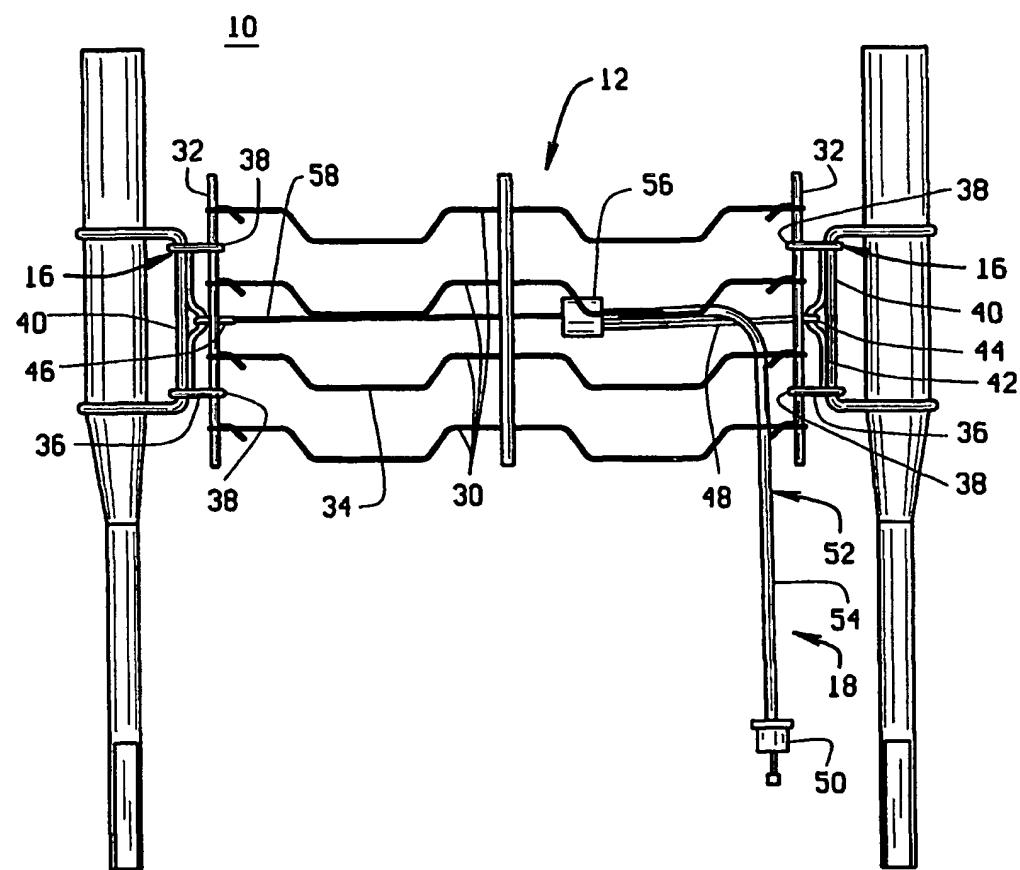


FIG. 3

3/3

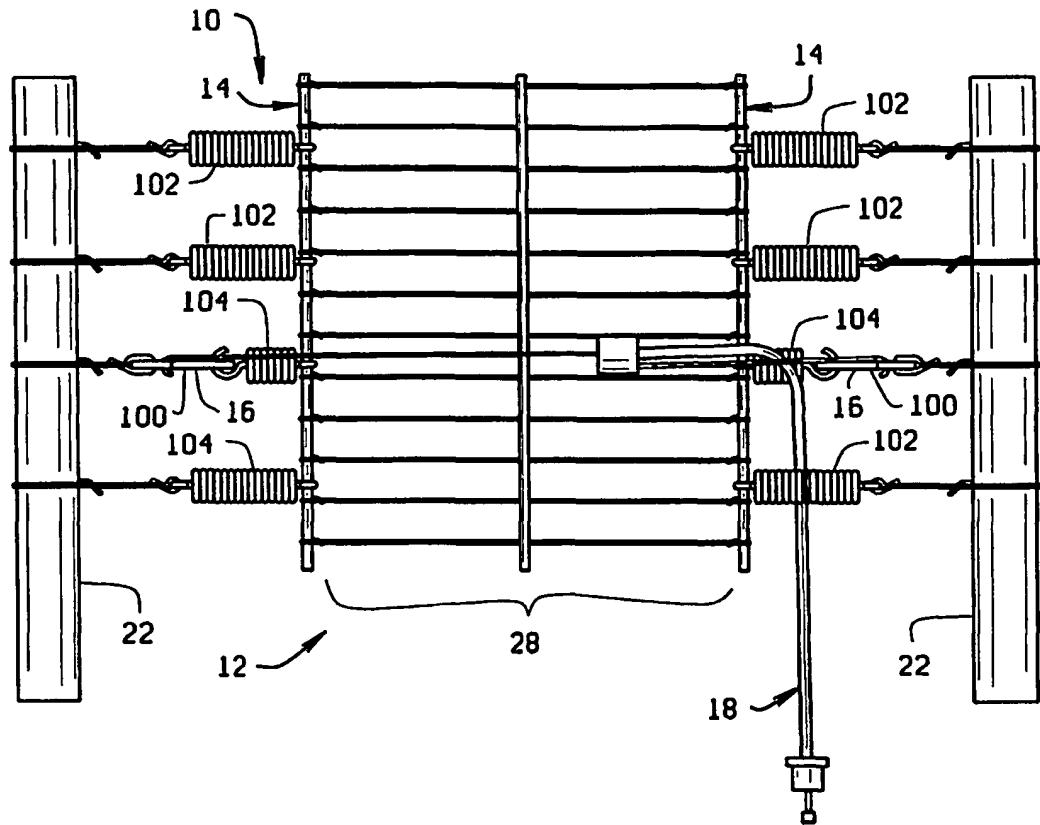


FIG. 4

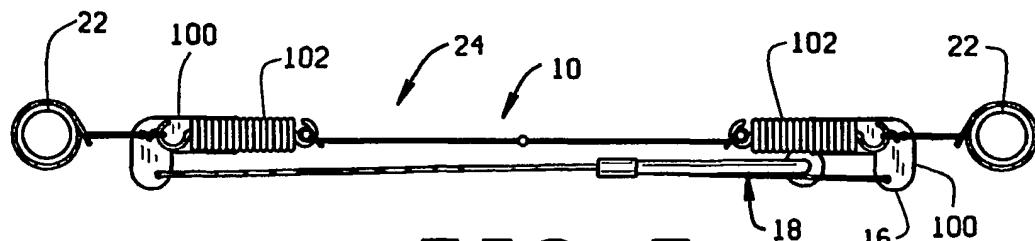


FIG. 5

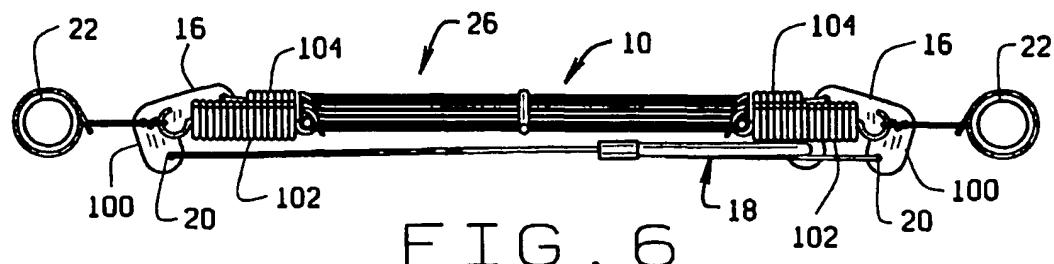


FIG. 6

**INTERNATIONAL SEARCH REPORT**

International Application No  
PCT/US 01/28863

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 A47C7/46

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 A47C B60N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category | Citation of document, with indication, where appropriate, of the relevant passages                                 | Relevant to claim No. |
|----------|--|-----------------------|
| X        | US 5 553 919 A (DENNIS MICHAEL R)<br>10 September 1996 (1996-09-10)<br>column 4-5; figure 7                        | 15,16                 |
| A        | US 5 507 559 A (LANCE MARK A)<br>16 April 1996 (1996-04-16)<br>claims 1,2; figures                                 | 1-14,<br>17-19        |
| A        | US 5 823 620 A (LE CAZ CHRISTIAN)<br>20 October 1998 (1998-10-20)<br>cited in the application<br>abstract; figures | 1,12,15               |
| A        | US 5 954 399 A (HONG JUNG-MYUNG)<br>21 September 1999 (1999-09-21)<br>abstract; figures                            | 1,2,15                |
|          |  | 1                     |
|          |  | -/-                   |

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

<sup>o</sup> Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the International filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the International filing date but later than the priority date claimed

- \*T\* later document published after the International filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*8\* document member of the same patent family

Date of the actual completion of the International search

15 January 2002

Date of mailing of the International search report

24/01/2002

Name and mailing address of the ISA  
European Patent Office, P.B. 5818 Patenttaan 2  
NL - 2280 HV Rijswijk  
Tel (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax (+31-70) 340-3018

Authorized officer

Amghar, N

## INTERNATIONAL SEARCH REPORT

Internal Application No  
PCT/US 01/28863

| C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT |   |                       |
|--|---|-----------------------|
| Category   | Character of document, with indication, where appropriate, of the relevant passages               | Relevant to claim No. |
| A  | US 5 466 045 A (AKIMA HIROAKI)<br>14 November 1995 (1995-11-14)<br>abstract; figures 1-3<br>_____ | 1                     |

2

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No  
PCT/US 91/28863

| Patent document cited in search report | Publication date | Patent family member(s) |               |                 | Publication date                       |
|--|------------------|-------------------------|---------------|-----------------|--|
| US 5553919                             | A 10-09-1996     | NONE                    |               |                 |  |
| US 5507559                             | A 16-04-1996     | AU 661509 B2            | WO 9305683 A1 | GB 2275188 A ,B | 27-07-1995<br>01-04-1993<br>24-08-1994 |
| US 5823620                             | A 20-10-1998     | NONE                    |               |                 |  |
| US 5954399                             | A 21-09-1999     | NONE                    |               |                 |  |
| US 5466045                             | A 14-11-1995     | NONE                    |               |                 |  |